**A NEW TECHNIQUE FOR HIGH-ACCURACY MEASUREMENT OF MERCURY OBLIQUITY AND WOBBLE.** M. A. Slade[1], J. K. Harmon[2], R. M. Goldstein[1], R. F. Jurgens[1], and E. M. Standish[1], [1]JPL/Caltech, Mail Stop 238-420, Pasadena, CA 91109-8099, [2]National Astronomy and Ionosphere Center, Arecibo, PR 00613 (harmon@naic.edu).

**Introduction:** A new technique is proposed for Earth-based high-precision measurements of Mercury's obliquity and libration in longitude. Mercury-orbiter-based measurements of these quantities will suffer from the large non-gravitational forces on such a spacecraft. In contrast, the Earth is a very well-characterized platform for making such observations referenced to "inertial space." In fact, the accuracy of this technique is so high that considerable initial effort will be needed to improve the knowledge of these quantities to the point where this new technique may be used.

**Objective of Measurements:** The value of this new technique is that, in combination with improved values of $c_{20}$ and $c_{22}$ for Mercury (from, e.g., an orbiter), the size and state of a putative fluid core can be determined. The existence of a fluid core is based on the magnetic field observed by Mariner 10 (1), which is explained most simply by a dynamo in a currently molten core. If Mercury has such a core, then Peale (2) has shown that dissipation will carry Mercury to rotational Cassini state 1 (in which the spin vector, the orbit precession angular velocity vector, and the orbit normal vector are all coplanar). Under plausible conditions, a libration $\phi$ in longitude will forced with an 88 day period (2). The dynamics of Mercury's orbit, along with the Mariner 10 gravity field and associated uncertainties, imply the following ranges accord to Peale (3):

$$1.7 \text{ arcmin} < \theta < 2.6 \text{ arcmin}$$
$$20 \text{ arcsec} < \phi < 60 \text{ arcsec}$$

The size and state of Mercury's core can be deduced from measurement of $\theta$ and $\phi$, along with determination of $c_{20}$ and $c_{22}$ of the gravity field to modest accuracy (3). Radar observations of (radar)bright features at the poles of Mercury have improved the limits on the obliquity (4). Further improvements in the knowledge of the obliquity, and measurement of $\phi$ present a challenging problem in astrometry. Radar imaging of the poles and the equatorial regions of Mercury using a baud of 0.2 microseconds has had a "proof-of concept" using the upgraded Arecibo telescope, but such observations cannot achieve the requisite accuracy in measuring $\theta$ and $\phi$ to a few arc-seconds Mercury-centered. (Such observations are essential, however, for improving their knowledge to the point where the proposed technique can be employed.)

**High Accuracy Measurements:** The new technique uses interferometry between observations of same subradar point on Mercury viewed in precisely the same geometry at greatly different times. The "baseline" is constructed from the two (very slightly different) positions of the observing point on Earth as viewed from Mercury. Detailed predictions will be shown for observations on Aug.17, 1998 (existing data) and Aug. 01, 1999 (new data). This technique uses some of the same mathematical formulations as (5) and (6). The "fringes" will exist within ~ 200 km radius spot surrounding the subradar point on the two dates, and will persist for ~2 hours if voltage data are obtained at the appropriate times. Other opportunities for these observations are June 2000-Sept 2003, May 2000-May 2004, July 2000-Aug 2004, July 2001-July 2004, and March 2000-Jan 2003.

**References:** References: (1)Ness et al., *Science*, **185**, 151-154, 1974; (2) Peale, S. J., in ***Mercury***, 461-493, Univ. of Arizona Press, 1988; (3) Peale, S. J., Lun. *Planet. Sci. XXVII*, 1081-1082, 1997; (4)Harmon et al., *Nature*, **369**, 213-215, 1994; (5) Goldstein et al., *Radio Science* **23(4)**, 713-720, 1988; (6)Zebker and Goldstein, *JGR* **91(B5)**, 4993-4999, 1986; Acknowledgments: Part of the research described above was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with NASA. The NAIC (Arecibo Observatory) is operated by Cornell under a cooperative agreement with the NSF and with support from NASA.